Reinventing the PhD

Keck Graduate Institute was founded as a result of a focused vision for creating a professional masters degree program that would educate students in science, management and bioethics for leadership roles in the life sciences industry. The Institute was born in the late 90’s, the brainchild of founding President Henry Riggs. During this period, a number of high profile publications had surfaced that were critical of American PhD programs in the natural sciences. These criticisms are as true now as they were ten years ago. The extended time to complete the degree, the narrow and overly focused aspect of the education and the inability of the graduates to operate effectively outside an academic milieu are all valid complaints against PhD education. These criticisms are particularly compelling in our current environment where academic positions are scarce and federal grants are awarded predominantly to senior investigators. Conversely, a number of industries, especially the pharmaceutical and biotech industries, are in dire need of scientific expertise, especially in non-research positions. KGI’s professional masters degree program has been in effect portrayed as the anti-PhD, a reaction to the sentiments of a number of prominent academics and corporate leaders. Our curriculum is broad, covering multiple scientific disciplines, pharmaceutical development, clinical regulatory affairs, management, finance and bioethics. The program is an MBS (Master of Bioscience) and is completed in two years, short by comparison to today’s PhD time to completion. Our program uses team projects as a pedagogical device to develop professional skills in communication, leadership and project management.

Given KGI’s tightly focused mission, considerable internal controversy surrounded our plans to launch a PhD program. The very thought seemed to be a betrayal of our mission. In the course of this debate and in an attempt to justify our program to the inevitable accrediting agency, we created mission statements for each of the two programs. This exercise was informative because it brought into focus the values and traits that have lead to success in PhD programs. The exercise also led us to the problems such programs confront.

Mission of the MBS program:
The MBS program educates a cadre of technically competent professionals for the bioscience industry who can oversee development of basic life sciences research into useful new products, processes and services and address the business and ethical leadership challenges confronting the applied life sciences.

Mission of the PhD program:
The PhD program endows a select group of students with the expertise in research areas relevant to applied bioscience, with the ability to use interdisciplinary tools and approaches to solve problems, and with the motivation to translate knowledge to beneficial applications to advance new horizons in the applied biosciences.

Note that there is nothing incompatible between the two mission statements. The mission statement and learning objectives of our PhD program are meritorious and largely consistent with the goals of most PhD granting programs. We seek to educate individuals to independently pursue original research and to solve complex problems. Certainly there is no lack of need for such individuals with
creativity and with the abilities to develop these skills. The objectives and desired outcome of this PhD program are compelling.

A closer examination of our learning objectives leads us to more fertile ground in discerning the disconnect between PhD programs and workforce needs. We established our learning objectives in three main areas: knowledge, values and professional skills. At this level of detail, the problems confronting the PhD become more apparent.

Knowledge: From KGI faculty meetings, I came to appreciate fully the range of curricular traditions in the natural sciences and engineering. Engineers and physical scientists often require a minimum of two years of solid course work. Biologists, on the other hand, favor getting students into the lab as soon as possible, forsaking course work for laboratory experience. The emphasis on knowledge is very strong in PhD culture. I remember telling a nervous PhD candidate about to enter his thesis exam, “Remember you are now the world’s expert in this narrow, little field. No one on your thesis committee knows as much about this area as you do. Just relax.” This attitude of being the world leading expert in a given narrow area will be immediately undercut by committee members or other faculty who will inform the candidate, “Don’t worry, no one ends up working in the field of their thesis work.” Both sides well illustrate the point—beyond the general knowledge base required to be functional, the value of the PhD does not reside in the specific knowledge of a field acquired during its five plus years of training.

Values: At first glance values as a learning objective would appear to be the weakest component of the PhD education in the sciences. I will argue that it is in fact the strongest. Certainly the ethical conduct of research has received much more attention than in the past. But this is not where the true value system lies. Because of the strong relationship between student and advisor in a PhD setting, the faculty mentor invariably imparts his or her values to the student. The mentor is part of a strong, but loosely connected community that shares these values. I might propose that two of the premier values of the community can be stated as follows:

There is no more noble pursuit than the generation of new knowledge.
You must inform the community of your new knowledge through peer reviewed publication.

These two value statements are at the core of academic scholarship. I remember sitting in a lab late one night and realizing that the equilibrium of a set of chemical reactions was not governed by the rate of formation but by the rate of disassociation. There was a great sense of power in that, not so much in understanding the phenomenon, but in knowing something that no one else in the world knew. When my advisor, an assistant professor, stopped by, I said, “We know how this works and we’re not telling anyone”. He was amused but did not heed my statement. There are a number of problems with this purely academic value system. The foremost of which is that these values do not apply well to nonacademic professions. In fact, these attitudes are diametrically opposed to those found in the business world, where knowledge is to be kept secret and leveraged to an entirely different advantage. Second, the value of generating new knowledge cannot be indiscriminate. Just because no one knows about it, does not mean that it’s worth investigating. In the academy, the discernment of the value of knowledge is largely left up to the federal grants program director. But in the industrial world, knowledge is generated in the employment of application. When enough knowledge is acquired to enable the application, efficiency of operation requires that knowledge gathering be limited.
Skills: The relationship between the student and the thesis advisor is at the core of the PhD experience. This relationship is the modern day equivalent of the age-old relationship between the master craftsman and the apprentice. The advisor attempts to impart his or her talents and wisdom for identifying important scientific problems, generating working hypotheses and designing a mode of attack, not only to test hypotheses, but to do so in a manner that generates new and interesting data and additional hypotheses. Intertwined with this investigative program are a number of skill sets: experimental acumen, computer programming, statistical analysis, and most importantly, the ability to communicate the work in a clear, comprehensible fashion, through seminars and through peer reviewed publications. The capstone of this skill set is the ability to propagate an individual research program through grantsmanship and the ability to broaden and generalize the understanding of the phenomena under investigation. In mentoring the student to become proficient in the process of science, the mentor also inevitably creates a professional crafted in his or her own image.

Successful PhDs end up acquiring a very sophisticated skill set that requires both an extremely caring mentor and a talented student. The ability of the student to independently attack and solve complex problems is, hopefully, the end result of the PhD education. Yet is this the only model to educate sophisticated “problem solvers?” The PhD reflects individual achievement and is judged accordingly. A candidate coming forth as a team player or facilitator simply would not make it. To be able to lead a team in solving problems is not part of the agenda nor would it be recognized as a legitimate accomplishment. At KGI, we are exploring other approaches to educating PhDs to do original, independent research while not channeling students too narrowly in any one disciplinary track.

The KGI Experiment

At KGI we are experimenting with a new form of PhD. We reaffirm the original premises of PhD training and support the education of students to be independent investigators capable of original research and complex problem solving. But we seek to broaden the set of problems that the student is equipped to tackle. To do this, we must extend the professional skill set of the PhD candidate to encompass team-based problem solving as well as the ability to formulate interdisciplinary and multidisciplinary approaches. To accomplish this goal we must shed some of the “rites of passage” that encumber existing programs. Our program has three crucial components outlined below. The key structural element of our program is that we require all students to complete our MBS program before moving on to the PhD. The MBS program delivers the professional skills and team-oriented abilities that we require of effective chief scientific officers.

Team Masters Project: Every PhD student must work in a team of three to five members on an industry sponsored project. This project is a contract research project with deliverables and timelines negotiated between the team and the industrial liaison. The team operates independently but does have a faculty member overseeing, but not directing, them. Team members learn leadership, project management and team organizational skills while tackling this interdisciplinary project that involves both business and technological aspects of a given problem. At the end of the yearlong project, students hone their communications skills by writing confidential reports for their sponsors and giving both confidential and non-confidential oral presentations. The TMP is the capstone experience of the MBS program at KGI. Because our PhD students do not have entry into the program before completing the MBS, they serve on equal footing with all other MBS students. We are currently unaware of any other PhD program that explicitly requires a team inquiry experience.
**Curriculum:** Unlike traditional PhD curricula, our curriculum is very broad covering a range of scientific disciplines that includes systems biology, computational biology and bioengineering. We also require students to take a significant number of courses in management, pharmaceutical development and bioethics. The bulk of the course work is fulfilled in the first two years of the program (the MBS portion); the goal is to train generalists with broad perspectives in their fields. Further “drilling down” into a discipline occurs as the thesis project dictates and is not explicitly introduced into the curriculum. The in-depth knowledge of a particular field is accomplished through literature clubs in which the students participate in the later years of the program. We contend that these short journal courses are more effective as students mature and become more advanced in their projects.

**The Mentoring Team:** An essential component of KGI’s new PhD program is the mentoring team. This is a group of faculty that includes the thesis advisor, the professional “godfather”, additional faculty, and an industrial advisor. The team has a more proactive role than most traditional thesis committees and is directly involved with the student’s development from the beginning. Most importantly, we have separated the scientific advisor from the professional advisor. The thesis (scientific) advisor plays the usual role in helping the student construct and execute the thesis project. The godfather (professional advisor) plays an entirely different role: this person advises the student more broadly about his or her career path. This role is to analyze the student’s strengths and weaknesses and provide advice that enables professional growth. A premium is put on inter- and multi-disciplinary projects and we anticipate that the other faculty members will be collaborators who will have an intrinsic interest in the project and in the student’s success. The industrial advisor is an outside contact who provides a valuable non-academic perspective on the student work. This model then breaks the master/apprentice mode and transitions to team-based mentoring that will, hopefully, provide a richer set of insights that aid the student and avoid project “tunnel vision.”

KGI’s model for a PhD program is both an experiment and a work in progress. The success of this experiment will depend, not so much on the details of the program, but on the faculty members’ commitment to educate the next generation of students in a new way—a way that fosters discovery and creativity over a wide range of problems, not just the academically pure or elegant problem of science, but those messy applied problems that need to be tackled with full rigor. The faculty must be committed to educating a generation of students, not in their own images, but in the new image of a researcher who is at ease in both academic and industrial settings. The challenge of such a program is to maintain the commitment to the original ideals of the PhD, the ideals of educating independent researchers who are capable of original work and are great problem solvers, while at the same time, open up the range of problems these researchers can and will approach.

T. Gregory Dewey  
Senior Vice President for Academic Affairs  
Keck Graduate Institute of Applied Life Sciences  
Claremont, CA  91711

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